Knowledge.

With which is incorporated Hardwicke's Science Gossip, and the Illustrated Scientific News

A Monthly Record of Science.

Conducted by Wilfred Mark Webb, F.L.S., and E. S. Grew, M.A.

DECEMBER, 1916.

SCIENTIFIC RESEARCH.

THE Government has decided to establish a separate Department of Scientific and Industrial Research for Great Britain and Ireland, under the Lord President of the Council, with the President of the Board of Education as Vice-President. It has also decided, subject to the consent of Parliament, to place a large sum of money at the disposal of the new Department, to be used as a fund for the conduct of research for the benefit of the national industries on a co-operative basis.

The Board of Inland Revenue has decided, with the approval of the Chancellor of the Exchequer, that no objection shall be offered by their Surveyors of Taxes to the allowance, as a working expense for income tax purposes, of contributions by traders to Industrial Associations which may be formed for the sole purpose of scientific research for the benefit of the various trades; and the allowance would be equally applicable as regards traders' contributions specifically earmarked to the sole purpose of the Research Section of an adapted existing Association.

In both cases the allowance would be subject to certain conditions; *e.g.*, the Association or the Research Section to be under Government supervision, and the trader's contribution to be an out-and-out payment, made from his trade profits, and giving him no proprietary interest in the property of the Association.

In order to enable the Department to hold the new fund and any other money or property for research purposes, a Royal Charter has been granted to the official members of the Committee of the Privy Council for Scientific and Industrial Research, under the title of the "Imperial Trust for the Encouragement of Scientific and Industrial Research." The Trust is empowered "to accept, hold, and dispose of money or other personal property in furtherance of the objects for which it has been established, including sums voted by Parliament to that end." The Trust can take and hold land, and can "accept any Trusts, whether subject to special conditions or not, in furtherance of the said objects."

A substantial gift has already been made to the Trust by two members of the Institution of Mechanical Engineers for the conduct of a research in mechanical engineering, to be approved by the Department, in the hope that this example will be followed by other members of the Institution.

Mr. H. Frank Heath, C.B., has been appointed Permanent Secretary of the new Department, to whom all correspondence should be addressed until December 31st next at the Offices of the Board of Education, Whitehall. On and after January 1st, 1917, all correspondence should be addressed to:—THE SECRETARY, Department of Scientific and Industrial Research, Great George Street, Westminster, S.W.

XUM

INHERITANCE OF TEMPERAMENT.

By PROFESSOR J. ARTHUR THOMSON, M.A., LL.D.

THE old theory of temperaments included within a husk of error a shrewd recognition of certain well-marked human types, and various attempts have been made to give a modern definition of what used to be called nervous, choleric, phlegmatic, and melancholic. The latest of these attempts is due to Dr. C. B. Davenport, Director of the Experimental Evolution Department of the Carnegie Institution, who approaches the subject as an expert on heredity. He has investigated eighty-nine family histories, which show in many cases the reäppearance of similar temperaments and moods, generation after generation. There is no doubt as to the heritability of the general pattern and bias of mind and mood; the question is whether the dominant temperament is a resultant of many components, or whether it is due to the presence or absence in the germinal inheritance of a particular entity—a "unit-factor"—such as we believe to exist in the inheritance of "night-blindness," albinism, and the like. What Dr. Davenport maintains is that the pedigrees of his eighty-nine families can be successfully interpreted on the hypothesis that there are in the germ-plasm two definite factors of excitability and of cheerfulness, on whose presence or absence the temperament of the offspring depends. In the author's judgment there is a deep dichotomy among men, "a dualism that runs through our whole population." It is between the "hyperkinetics" and the "hypokinetics," the quickly reäcting and the slowly reäcting, the enthusiast and the reflective, the romantic and the classic, the radical and the conservative, the feebly inhibited and the strongly inhibited. The two contrasted types are to be seen in all sorts of garbs. "In business, the bold, energetic, dashing promoter and the solid, conservative, thrifty merchant; in law, the emotional jury-lawyer and the learned judge; in medicine, the skilful operator in difficult cases and the skilled diagnostician and consultant; in divinity, the magnetic evangelist and the profound theologian or exegetist; in war, a dashing Sheridan and a solid, quiet Grant." All this reminds us of the contrast William James insisted on between "the two types of mental make-up," which he called the tender-minded and the tough-minded. The former, idealistic, optimistic free-willist, correspond to the hyperkinetics; the latter, going by "facts," pessimistic, fatalistic, correspond to the hypokinetics. Of course, the American scientist, like the American philosopher, is willing to admit that the bulk of mankind is neither on the one side nor the other, but that most of us exhibit a mixture of ingredients which makes for a sort of humdrum happiness. But James and Davenport agree as to the reality of the dichotomy, and in maintaining that even the apparent blends are facing definitely in one direction. It is at any rate interesting to think over the theory of a deep dichotomy among men.

All through the realm of organisms we can detect an ever-recurrent dualism. It separates the hypokinetic plant and the hyperkinetic animal as surely as it differentiates the relatively anabolic female and the relatively katabolic male. We see it where the genealogical tree of animals splits at the top into birds and mammals, both arising from saurian stocks; we see it at the very base of the tree, in the antithesis between the intensely active infusorians and the slow-going amoebae. It is the contrast between coral and ctenophore, between barnacle and shrimp, between ascidian and fish—an ever-recurrent forking of the branches. The significance of it is not mystical; it simply means that the fundamental alternatives of physiological régime are in the directions of spending or of saving. For the fundamental processes of life are twain—up-building and down-breaking, constructive and disruptive, anabolism and katabolism—and while structural changes need not make much difference one way or the other, a change of physiological habit or vital economy is likely to have a bias towards one of the two main possibilities, that of living more dangerously, *i.e.*, more nearly up to income, or that of living more comfortably, *i.e.*, with expenditure well on the safe side. Hence the pervasive dualism; and an organism, unless peculiarly successful in pursuing a middle path, *tutissimus in mediis*, must be facing one way or the other. Moreover, the dualism is apt to seem more clear-cut than it is, since we fix our attention on certain aspects in which the creature is pronouncedly lavish in its expenditure, and ignore or forget others in which it is restrained or even miserly. Even a plant has now and again its animal touch, as we see in the Venus Fly-trap or the Sundew, and many an animal is vegetative.

To return, however, to Dr. Davenport, we find him convinced of a deep dichotomy in mankind between the hyperkinetic and the hypokinetic, the spenders and the savers. But both types have two grades of expression, which correspond, he thinks, to the nervous and choleric temperaments on the one hand, and to the phlegmatic and melancholic temperaments on the other hand. The "nervous" person is "active, energetic, irritable, excitable, ambitious, given to planning, optimistic, usually talkative, and jolly." The "choleric" person goes further along the same *hyperkinetic* line:

he is over-active, shifting from one thing to another, usually hilarious, passionate, even violent. The "phlegmatic" person is characterised by quietness, seriousness, conservatism, and pessimism. The "melancholic" individual goes further along the same *hypokinetic* line—unresponsive, taking things lying down, weak, given to worry, and even to tears, one to whom life is a burden. What Dr. Davenport's studies have led him to is the conclusion that these four temperaments, corresponding in a general way to those of olden times, are heritable in a more precise sense than is usually supposed. His particular hypothesis is that temperament in man is "determined" by a pair of hereditary, germinal factors—a factor for excitability, the absence of which spells placidity, and a factor for normal cheerfulness, whose absence spells depression. These factors may be inherited independently of one another, and there are a number of possible combinations. With rare exceptions the offspring of two very excitable parents are excitable; of two placid parents, placid. If one parent is depressed and the other cheerful, the offspring are likely to look on the bright side of things; but if both parents are gloomy the children will be gloomier still. In regard to all such theories one must ask whether the basis of facts in reference to which they are tested is large enough and representative enough, and it should be noted that Dr. Davenport deals with only eighty-nine family histories, and that these partake very largely of the pathological. It need hardly be said that no family history was selected because it was foreseen that it would fit the hypothesis, or rejected because it was opposed thereto. Among the six hundred and twenty-nine offspring investigated, less than one per cent. had temperaments other than might have been anticipated. Out of one hundred and thirty-three offspring of highly excitable parents, only six were "normals"—normal meaning the sensible, well-balanced, moderate sort of person who "is uniformly cheerful without being boisterous."

If Dr. Davenport's theory of the inheritance of temperaments be not accepted, what alternative is there? There may be an occasional instance of a cheerful child who becomes gloomy to please its melancholic parents, or by force of imitation and suggestion, or by a survival of repressive domestic tyranny, but we cannot make much of a theory out of this. A more defensible view has been previously hinted at—that a temperament is a resultant of many components, a product of all sorts of nurture, as well as of hereditary nature. Much depends, as Davenport, of course, admits, on bodily conditions; for excitability is associated with low arterial tension, and that, again, is influenced by internal secretions, such as those of the supra-renal bodies. A man's temperamental outlook is greatly affected by the state of his eyes or by the adequacy of his digestion. Much, also, depends on psychical factors, of whose physiological correlates we know next to nothing—an ideal, an ambition, a passion. It is also certain that social conventions and traditions count for something; for different circles taboo different temperaments. It would be absurd to suppose that the state of one's purse and of one's apparel is anything like as important as the "gene" that was in one's germ-plasm, for melancholic millionaires and cheerful vagabonds are familiar; but there is no denying that these things count in making up our moods if not our temperament. Indeed, Dr. Davenport used to share this view, and he says: "Even yet I find it difficult to get rid of the prejudice that example, teaching, experience, and state of health may do much to modify one's behaviour." We confess that we cannot get rid of this prejudice, which seems to us to be rooted and grounded in facts. Nor can we accept a view which makes our inheritance like a portmanteau, out of which you can get nothing that was not put into it in the packing. Dr. Davenport is in no way dogmatic over his theory, but he firmly maintains that no hypothesis fits the facts anything like so well as that of the germinal presence or absence of cheerful and excitable "genes." Our view is wider and more elastic: that while there may be special germinal factors whose presence or absence determines clean-cut excitability or extreme nonchalance, riotous high spirits or melancholia, the temperaments of most of us, are complex resultants of many factors—bodily and mental, individual and social, environmental and occupational—and made as much as born, just like our character.

NOTES.

ASTRONOMY.

By A. C. D. CROMMELIN, B.A., D.Sc., F.R.A.S.

The September number of *Proceedings of the U.S.A. National Academy of Sciences* contains three interesting papers from Mount Wilson Observatory. The first, by Mr. F. G. Pease, discusses the rotation and radial velocity of the spiral nebula, N.G.C. 4594. Since spiral nebulae have a continuous spectrum, their light is far more spread out than in gaseous nebulae, and a great exposure is required; in this case eighty hours were given, distributed over the months of March, April, and May last. An ingenious arrangement has been made of several slits arranged to photograph the spectra of different parts of the nebula on the same plate, with comparison spectra between. The latter spectra are obtained by sparking between iron electrodes, and therefore show the iron lines. The result is a series of ten parallel spectra, which belong to equidistant regions of the nebula extending 2½′ on each side of the centre. These spectra resemble that of a star of type F5, *i.e.*, intermediate between the type of Procyon and that of the Sun. The measured speed of recession varies uniformly from eight hundred kilometres per second at one end of the photograph to

one thousand six hundred and thirty at the other end. It is inferred that the nebula is receding from us at the rate of one thousand one hundred and eighty kilometres per second (in good agreement with one thousand one hundred found by Slipher), and in addition it is rotating with approximately uniform angular velocity about the centre, the rotational speed at 2′ distant from the centre being three hundred and thirty kilometres per second. It is inconceivable that such a vast structure could really rotate as a rigid body; but the same effect would be produced if the matter were so distributed that the attraction to the centre varied as the direct distance, since the periodic time would then be the same for all portions. This nebula is turned edgewise to us, so we cannot measure the apparent rate of angular rotation.

On the other hand Messier 101 is a spiral which we view unforeshortened, and Mr. A. van Maanen has investigated its rotation by comparing large-scale photographs with a time interval of several years. He finds for the bodily motion of the nebula +″·005 in R.A., and −″·013 in Decl. per annum. The rotation is clockwise, and its annual value is as follows:—

Distance from Centre.	Annual Linear Shift due to rotation.
Less than 3′·1	″·024
3′·1 to 5′·0	″·028
5′·1 to 7′·0	″·014
More than 7′·0	″·019

In this nebula the linear shift does not appear to vary proportionally to the distance from the centre (as in N.G.C. 4594). The mean value at 5′·0 from the centre is ″·022, so that this portion of the nebula would complete a rotation in $600\pi \div 022$ year = 86,000 years. By comparing the angular bodily shift of the nebula with the mean radial velocity of spiral nebulae, Mr. van Maanen obtains ″·0003 as the hypothetical parallax of Messier 100 (distance 11,000 L.Y.). Mr. Pease gives 25,000 L.Y. as the hypothetical distance of N.G.C. 4594. These distances are of the same order of magnitude as those found by Mr. Curtis from a comparison of the linear motions and radial velocities of other spiral nebulae. If correct, these nebulae appear to lie considerably outside the limits of our Galaxy.

Mr. F. H. Seares describes a photographic method of determining the degree of redness of a star by taking a series of exposures on the same plate (which should be isochromatic), some with a yellow filter and some without. It is then possible to determine the time ratio for images of equal size with and without the screen. The smaller the ratio the redder the star is. It is about three for stars of type M and about eight for those of type A.

Mr. Harlow Shapley has worked out by a photographic method the colour indices of the stars in four globular clusters (Messier 3, 5, 13, 15 respectively). He finds that the brighter stars in all of them (magnitude 12 to 13) have colour indices about 1·3, and are therefore red while the fainter ones (magnitude 15 to 16) have colour indices about 0·3, and are therefore nearly white. The conclusion drawn is in favour of Professor H. N. Russell's division of red stars into giants and dwarfs, the former being, at an early stage in their career, of immense size, low density, comparatively cool, but yet giving a great amount of light from the great extent of their surface. The blue stars are much hotter, but their surface is so much reduced that the total light emission is less. Mr. Shapley has also investigated the great cluster in Hercules, M 13, and finds that of the four hundred brightest stars seventy-five per cent. are redder than type Go, while of the four hundred faintest stars measured eighty-five per cent. are bluer than type Go. He pictures these globular clusters as being far outside our stellar system, and assigns the hypothetical distance 100,000 L.Y. to the Hercules cluster. One objection to this view is that the clusters show a distinct tendency to group themselves along or near the Galaxy, which could scarcely be the case if they were far outside it.

CHEMISTRY.

By C. AINSWORTH MITCHELL, B.A. (OXON), F.I.C.

FIRE-PROOF WRITING PAPER.—Various patents have been taken out for paper which is claimed to be proof against fire, and therefore particularly suitable for documentary records. Most of these contain asbestos, or a similar mineral fibre, with or without the addition of clays or metallic salts. In a recent issue of *The Journ. Ind. and Eng. Chem.* (1916, VIII, 888) Mr. R. G. Myers publishes the results of his experiments to determine which was the most suitable composition for this purpose. Pulps were made from crysotile fibre, and incorporated with white precipitated compounds of various metals, and the paper was prepared from these by hand. It was found that for closeness of texture and tensile strength the best results were obtained with pulps containing precipitated hydroxides, silicates, arsenites, and tungstates, while the most satisfactory of all the papers tried was that containing magnesium arsenite.

In testing the resistance of the papers to fire the samples were exposed for ten hours to temperatures of 900° to 1,000° C., but none was entirely satisfactory under those conditions, although several of the papers could be exposed to dull red heat for an hour or two without suffering any material injury.

The conclusion is drawn that no foreign ingredient can increase the stability of asbestos against fire, and that it is probable that no paper composed of incombustible substances containing water in molecular combination is really fire-proof. Some varieties of "true asbestos," however, retain their combined water with greater obstinacy than crysotile, and these would be more suitable for fire-proof paper.

Solutions of ferric, chromic, and cobaltous nitrates were used as the inks on these papers, and resisted the fire test. According to Arkel (*Canadian Govt. Bull.*: Asbestos), no inks tried up to that time would stand a red heat, with the exception of those containing platinum compounds. It appears from the experiments of Mr. Myers that in using inks other than platinum inks it is essential that the paper should contain an excess of acid oxides.

A NEW POTASH FERTILISER.—According to a U.S.A. commercial report (September 23rd, 1916), a fertiliser is now being prepared in Spain from the mother liquors left from the manufacture of sea-salt. This product, which is termed "marine kainit," and contains about twelve per cent. of potash, is left on evaporating the mother liquors to dryness. It is claimed to be quite as good a fertiliser as ordinary kainit, while its superior hygroscopic properties are an advantage.

NEW SOURCES OF OIL IN GERMANY.—The *Zeitschrift für angew. Chem.* (1916, XXIX, 237) calls attention to the numerous sources of oil which have hitherto not been properly utilised. Thus asparagus seeds contain twelve per cent. of oil, and the residue would be suitable for fodder. Cherry-stones, large quantities of which are to be obtained from the manufacturers of cherry liqueurs in South Germany, yield a considerable amount of oil which could be readily extracted. A guild of German women has undertaken the collection of cherry-stones with this end in view. Lime-tree fruit yields from nine to ten per cent., and elm-tree fruit from nine to fourteen per cent., of oil. Other suitable sources are horse-chestnuts and maple fruit—both of which contain a large proportion of oil—pear-pips, apple-pips, and canary seeds. In the case of some of these seeds, *e.g.*, horse-chestnuts, a regulation has been made that the oil must be extracted before the material is used for fodder.

XUM

GEOGRAPHY.

By ALEXANDER SCOTT, M.A., D.Sc.

THE NILE RIFT VALLEY.—In *The Geographical Journal* (August, 1916) Stigand gives an account of the tectonic features of the Upper Nile Valley, and Holmes discusses its structure. The former writer attributes the recent earthquakes to movements along an east and west fault somewhere in the neighbourhood of Rejaf, and not to the great north and south strike fault which forms the prominent scarp along the west side of the valley. The latter seems to have diverted the Victoria Nile in a northerly direction, while the Murchison Falls are due to a parallel fault on the eastern side of the Rift Valley. Before the occurrence of the faulting the present Congo-Nile watershed was not in existence, and the Victoria Nile probably continued in a north-westerly direction. Of the several possible outlets the one favoured by Stigand is the Wadi-el-Fardi, which would connect with the present Nile Delta and at the same time would give an explanation of the remarkable resemblance between the fish-fauna of the Nile and that of Lake Chad. On the other hand Gregory has suggested that the watershed lay originally to the north of Lake Victoria Nyanza, and that the latter lake drained eastwards, but that finally the subsequent elevation of the country to the north-east induced the present form of the drainage. More information, however, regarding the Western Egyptian Sudan is required before the drainage systems can be properly explained.

TRIANGULATION IN THE KARAKORAM.—The sixth volume of the "Records of the Survey of India" (Cf. *Geog. Journ.*, November, 1916) deals with the linking-up of the triangulations of India and Russia. The work was carried out under conditions of extraordinary difficulty, due to the severe climate and the high altitude, the average height above sea-level of the stations being over sixteen thousand feet. The Indian connection was made from Gilgit, which some years ago was linked up with the Indian system through Rawal Pindi, while on the Russian side the triangulation started from a base near the town of Osh. So far, this base is independent of the main Russian triangulation, and when it is connected with the latter the results of the present work will have to be recalculated. The report also contains interesting details of the geology and zoölogy, as well as a number of valuable observations on mountain-sickness. It is found that during an ascent the number of red blood-corpuscles increases until, at a height of ten thousand feet, the increase is over sixty per cent. If, however, the rate of ascent is too rapid to allow the development of this excess of red blood-corpuscles, mountain-sickness ensues.

GEOLOGY.

By G. W. TYRRELL, A.R.C.S., F.G.S.

THE GREAT LAVA PLATEAUX OF ICELAND AND INDIA.—Probably the most remarkable manifestations of igneous activity are the huge basalt plateaux, of which the most prominent are the North Atlantic area, stretching from North-west Britain through Iceland to Greenland on the one hand, and to the Faroes on the other; the Deccan Traps, covering about 200,000 square miles, in Central India; and the great lava deserts of Western America, which cover an area of similar size. There is still considerable dubiety as to the origin of these immense outpourings of basalt, and they have been attributed to fissure eruptions, as opposed to central eruptions of the Vesuvius type; but much more detailed work is necessary before the many doubtful points can be cleared up. Consequently, the recent work carried out by Mr. L. Hawkes in Iceland (*Geological Magazine*, September, 1916) and by Dr. L. L. Fermor and Mr. C. S. Fox in India (*Records of the Geological Survey of India*, Volume XLVII, 1916) is especially welcome. Mr. Hawkes discusses the origin of the red partings formed between the successive basalt flows in Iceland in relation to the building of the North Atlantic Tertiary volcanic plateau, the probable time that elapsed between successive flows, and the total duration of the volcanic period. Microscopic investigation shows that the red partings consist of volcanic ash, in which the fragments are of altered glass (palagonite). The included felspar and augite crystals have remained perfectly fresh. The red partings have been considered as old land surfaces, and have been held to indicate a considerable lapse of time between successive flows. Mr. Hawkes, however, regards them as analogous to the tuff-dust deposits at present to be found upon the fresh surfaces of the modern lava deserts of Iceland. These may be accumulated or dispersed by wind within a few days, and hence may represent a period of time to be measured only by days before being sealed up by a fresh flow. "The rising of a wind a few hours before eruption may make all the difference as to whether a basalt is to be accompanied by a tuff or not, and by this interpretation of the red partings we are guarded from attaching too much importance to their occurrence and thickness, which may be purely accidental." By various means Mr. Hawkes arrives at a figure of a million years for the building up of the Tertiary volcanic plateau in Iceland, but an immensely longer time would be required for the enormous erosion it has since undergone.

Dr. L. L. Fermor and Mr. C. S. Fox have mapped in detail a selected area of sixty-five square miles in the Deccan Traps, near Linga, Central Provinces of India. The number of flows is five, with an average thickness of sixty feet each. They consist of basalts, vesicular and fine-grained at top and bottom, but grading into comparatively coarse dolerites in the centres of the flows. They rest directly on the Archaean granites and gneisses. The flows are separated one from the other, not only by vesicular surfaces, but usually by a small thickness of freshwater fossiliferous sediment, or of "green earth," or of both together. The "green earth" has been formed by the alteration of the base of each flow. The mapping shows that the flows, originally horizontal, have been bent into a parallel series of gentle anticlines anp synclines, which are parallel to the direction of foliation of the Archaean gneisses of the neighbourhood; and it is suggested that this folding is a feeble repetition or echo of the compressive stresses which were applied so much more intensely in remote Archaean times.

METEOROLOGY.

By WILLIAM MARRIOTT, F.R.Met.Soc.

CIVILISATION AND CLIMATE. — Dr. Ellsworth Huntington has published an interesting book on "Civilisation and Climate," in which he endeavours to show that civilisation is largely dependent on climatic influences. He has collected a large amount of statistics and information bearing on the subjects of race, the white man in the tropics, the effect of the seasons, humidity and temperature, and also work and weather. He then deals with the distribution of civilisation, vitality and education in the United States and the conditions of civilisation. After investigating the shifting of climatic zones and the shifting of centres of civilisation, he leads up to the climatic hypothesis of civilisation. His general conclusion is as follows:—"The two phases of our climatic hypothesis are now before us. In point of time the first step was a study of the past. Ten years of work along this line led to the hypothesis of pulsatory changes, and finally to the idea that the changes consist primarily of a shifting of the belt of storms. After this conclusion had been reached a wholly independent investigation of the effect of present climatic conditions upon human activity

led to two conclusions, neither of which was anticipated. One was that under proper conditions a relatively high temperature is not particularly harmful provided it does not go to undue extremes. The other was that changes of temperature from day to day are of great importance. On the basis of these two conclusions it at once becomes evident that the stimulating effect of climates in the same latitude, and having the same kind of seasonal changes, may be very different. It also becomes clear that the distribution of civilisation at the present time closely resembles that of climatic energy. From this the next step is naturally back to our previous conclusion that changes of climate in the past have consisted largely of variability in location of the storm-belt. If this is so, evidently the amount of climatic stimulus must have varied correspondingly. Thus we are led to the final conclusion that not only at present, but also in the past, no nation has risen to the highest grade of civilisation except in regions where the climatic stimulus is great. This statement sums up our entire hypothesis. Other explanations may indeed be offered, and modifications will certainly be necessary. Yet unless we have gone wholly astray, the surprising way in which independent lines of investigation dovetail into one another seems to indicate that a favourable climate is an essential condition of high civilisation."

THE ENGLISH CLIMATE IS THE BEST.—In his "Civilisation and Climate," referred to above, Dr. Ellsworth Huntington, when dealing with "the ideal climate," says:—"England apparently comes nearer to the ideal than almost any other place. The climate is stimulating at all times, both by reason of abundant storms and because of a moderate seasonal range of temperature. It never, however, reaches such extremes as to induce the nervous tension which prevails so largely in the United States."

MICROSCOPY.

By F.R.M.S.

OBSERVATIONS ON THE BLADDERWORT.—The Bladderworts are rootless floating aquatic plants which are found in ponds and ditches in several parts of this country. The main stems bear numerous finely divided leaves, and on these occur small bladders. In the case of *Utricularia vulgaris*, the commonest species, the bladders are about one-eighth of an inch in length; in *U. neglecta*, about one-tenth of an inch. Each bladder is supported on the leaf by a short foot-stalk, and is of a transparent green colour. It is somewhat egg-shaped (see Figure 194), and flattened laterally. At the entrance to the bladder is a valve, which yields to pressure from the outside. Round the rim are bristles of various lengths, the two longest being branched. The internal wall of the bladder bears numerous quadrifid processes (see Figure 195), which probably absorb decaying organic matter.

There has been much speculation as to the function of the bladders. The original theory was that they served to buoy up the plant in the water by becoming filled with air; but such support has since been shown to be unnecessary, as plants denuded of bladders are found still to float.

The *present* theory is that small aquatic animals, prompted apparently by curiosity or in an endeavour to escape from their enemies, enter the bladders by pushing open the valve. Once inside there is no escape, as the valve only yields to pressure from the outside, and after death the juices, the product of their decay, are absorbed by the plant.

This latter theory may seem very feasible, but after much observation I must say that I have never seen any animal *force* an entrance, and yet the bladders are always well stocked.

Writing of the Bladderwort, Darwin, in "Insectivorous Plants," says: "On three or four occasions I have seen long narrow larvae, both dead and alive, wedged between the corner of the valve and the collar, with half their bodies within the bladder and half out.

"As I felt much difficulty in understanding how such minute and weak animals as are often captured could force their way into the bladders, I tried many experiments to ascertain how this was effected. A thin human hair, fixed to a handle, and cut off so as to project barely a quarter of an inch, entered with some difficulty; a longer piece yielded instead of entering. On three occasions minute particles of blue glass were placed on valves whilst under water, and on trying gently to move them with a needle, they disappeared so suddenly that, not seeing what had happened, I thought that I had flirted them off; but on examining the bladders they were found safely enclosed. . . . To ascertain whether the valves were endowed with irritability, the surfaces of several were scratched with a needle, or brushed with a fine camel-hair brush, so as to imitate the crawling movement of small crustaceans, but the valve did not open."

He then sums up by saying: "We may therefore conclude that animals enter merely by forcing their way through the slit-like orifice, their heads serving as a wedge. But I am surprised that such small and weak creatures as are often captured (for instance, the nauplius of a crustacean, and a tardigrade) should be strong enough to act in this manner, seeing that it was difficult to push in one end of a bit of hair a quarter of an inch in length."

In order to investigate this interesting question, I took a few specimens of a Bladderwort (*U. neglecta*) from a pond in Epping Forest last April, and put some into an aquarium in tap water, and the others in water containing a varied assortment of small creatures.

A popping noise was heard on taking the plants out of water, and after replacing them the bladders were observed to contain air. Plants grown from winter buds, and never removed from the water, had bladders which contained only water and no air.

On May 1st, in the second aquarium mentioned, a small tadpole (one-third of an inch long) was found held with its head in one bladder and its tail in another (see Figure 196). The poor prisoner was still alive, but quite unable to effect its escape. Its head was distorted, as though sucked into the bladder with considerable force. Surely this awkward position and uncomfortable state of affairs for the tadpole were not brought about by the victim's prying curiosity, and the idea of investigation by its tail is incredible.

A tadpole was then killed and brought near a bladder. When within about a thirty-second of an inch of the mouth it was quickly sucked in, and remained there firmly fixed. This experiment was repeated many times, with the same results, in twenty per cent. of the cases. No bladder, however, would respond again after it had once done so, even after one hour had elapsed. All the bladders on one plant were then touched, and left till next day.

On May 2nd (fifteen hours later) the experiments were repeated, and about ten per cent. of the bladders were sensitive to touching, the sensitive parts being the short bristles (see Figure 194) and the rim of the mouth of the bladder. I was unable to ascertain whether the valve was also irritable, because in touching this I could not avoid contact with the rim also. The case of one bladder, of rather large size, and containing an air bubble, was rather remarkable. On touching the pair of longest bristles the bubble suddenly sprang forward (see Figure 197), as if swept round by an influx of water through the valve, and one would expect that had any object been near the mouth it would have been drawn into the bladder. It was subsequently proved, in the case of several bladders containing small bubbles of air, that when the bubble in a bladder moved forward any object at its mouth was sucked in. But the singular part of this case is that the *long* bristles were irritable. This was never found to be the case in any later experiment. Of course, a possible explanation might be that the smaller bristles, or the rim, were jarred by the long bristles being touched.

If all the bladders of a plant were rendered inactive by touching the bristles, it was found that about fifty per cent. of the bladders had again become sensitive at the expiration

UTRICULARIA

(BLADDERWORT).

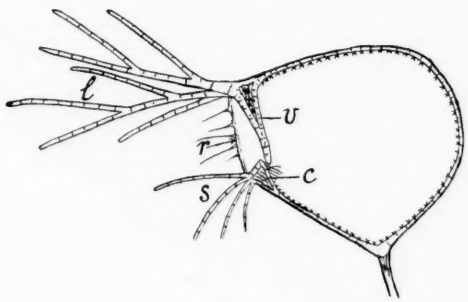

FIGURE 194.

Longitudinal section of a bladder of *Utricularia neglecta*:

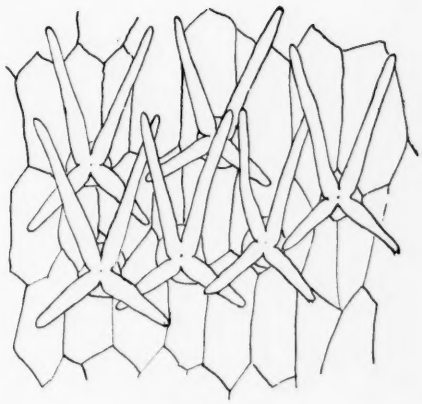

FIGURE 195.

Quadrifid absorptive processes on the inner wall of the bladder:

l, long bristles; *s*, short bristles; *r*, rim at mouth; *v*, valve; *c*, collar.

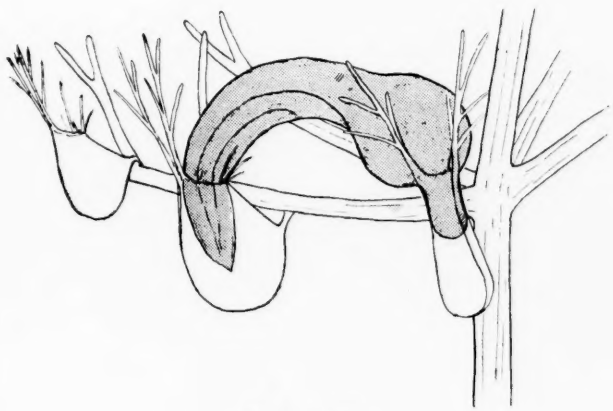

FIGURE 196.

A small tadpole held by two bladders:

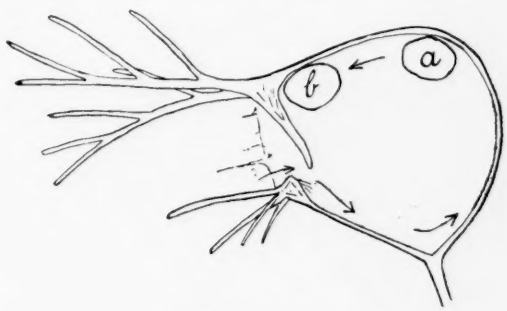

FIGURE 197.

Bladder, showing the direction of movement of an air bubble:

a, first position; *b*, second position, after bristles had been touched. The arrows indicate the direction of the current of water in the bladder.

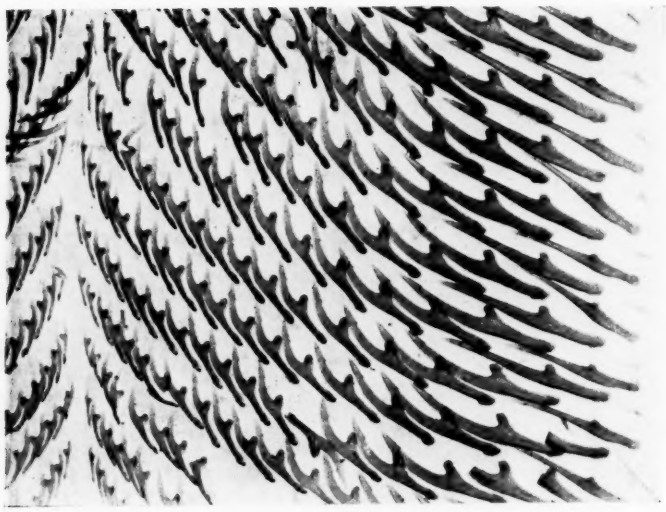

FIGURE 198.
Radula of *T. haliotidea* (stained).

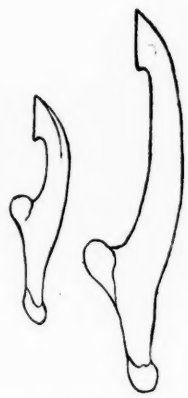

FIGURE 199.
Outline drawings of two "teeth" of *T. haliotidea*.

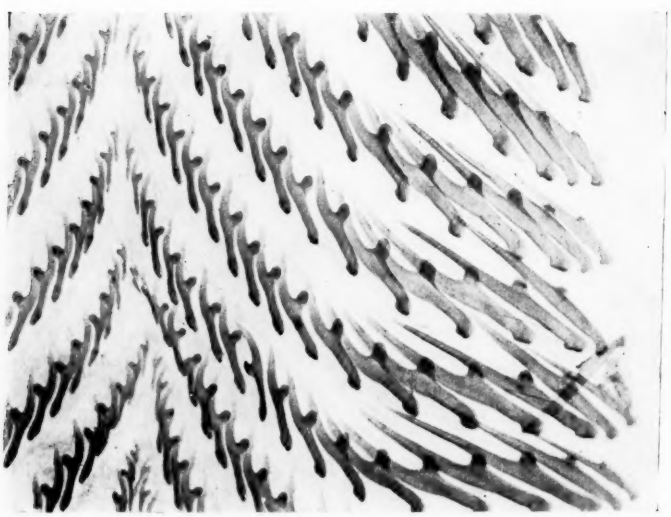

FIGURE 200.
Radula of *T. scutulum* (stained).

FIGURE 201.
Outline drawings of two "teeth" of *T. scutulum*.

Figures 198 and 200 are from Photo-micrographs by E. W. Bowell.

of twenty-four hours; and if forty-eight hours were allowed to elapse, nearly all of them responded to stimulation. The irritability of the bladders was in no way diminished by their already containing animal matter.

In all these experiments the temperature of the water was 23° C.

Having seen that organic matter was sucked into the bladders on touching the mouth, it was now necessary to test with inorganic matter. Mercuric oxide seemed well suited for this purpose, as it was easily observed, on account of its red colour and its insolubility in water. A little was taken on a finely pointed glass rod, which was introduced carefully into the water. Some oxide dropped off, but enough remained for observation. On touching the short bristles with the rod, some oxide was swept into the bladder, where it could be distinctly seen through the transparent walls. This experiment was repeated successfully a number of times, showing clearly that non-nitrogenous inorganic matter, as well as organic matter, can be taken in by the bladder.

Close observation seems to show that when a bladder becomes sensitive the walls become concave. It appears to me that on stimulation of the bristles the walls spring back to their normal position, thus enlarging the cavity of the bladder, and so causing a sudden inward current of water and the opening of the valve. Any object near the orifice is carried in by the current, and is retained by the valve, which closes and prevents all egress. The popping noise noticed when the plant is taken out of water can be accounted for as being due to air entering the bladders, which are irritated by their removal.

C. L. WITHYCOMBE.

THE BRITISH SPECIES OF *TESTACELLA* (*continued*).—We now compare the radulae of *Testacella haliotidea* and *T. scutulum* with that of *T. maugei* and with each other, using for the purpose two more of the photo-micrographs, which we owe to the courtesy of Mr. E. W. Bowell. These bear out one's notes to the effect that the "teeth" in *T. scutulum* are more slender and not so much curved, while the barbed end is not nearly so large and strong (see Figures 198 to 201). The number of "teeth" on each side of the radula of *T. maugei* in two specimens was found to be fourteen, while in the other species there were seventeen, eighteen, or nineteen.

W. M. W.

PHOTOGRAPHY.

By EDGAR SENIOR.

TEST FOR SILVER CHLORIDE.—A test for silver chloride devised by Valenta is given in a recent number of *The Photographic Journal of America* by Professor E. J. Wall. The test depends upon the formation of silver ferrocyanide when a solution of potassium ferrocyanide is brought into contact with silver chloride, a reaction which does not take place in the case of either the bromide or the iodide of silver. As silver ferrocyanide is white, its presence cannot be directly detected. If, however, the precipitate be well washed, to remove all trace of any remaining soluble ferrocyanide, and the silver ferrocyanide be then treated with nitric acid, an orange-red ferrocyanide is produced. A more delicate test still is to treat the silver ferrocyanide with a mixture of either ferric chloride and potassium bromide or uranium nitrate and potassium bromide, when by double decomposition silver bromide is formed; and in the case of the iron salt an intense blue colour results; while with uranium a reddish brown precipitate of uranium ferrocyanide is produced. These tests are easily applied to any sensitive film, all that is necessary being first to ensure the absence of soluble silver salts by a preliminary washing, and to work in weak daylight when the nitric acid test is to be employed, or in an artificial light which is poor in actinic rays when either of the other tests is used, since the partial decomposition of silver bromide by light would result in the formation of a small quantity of silver ferrocyanide on the application of the solution of potassium ferrocyanide. These reactions may also be made use of for the detection of a chloride in a mixture of haloids by first converting them into insoluble silver haloids.

USE OF SCHLIPPES SALT IN SULPHIDE TONING.—Schlippes salt, which is a double sulphide of soda and antimony, has been recommended at various times as useful in the sulphide toning of bromide prints; the colour obtained, however, is not generally satisfactory; but by a modification of the process, which the writer believes was originally published in *Camera Craft*, rich brown tones may be produced even upon prints which are lacking in the vigour necessary with the methods of toning commonly employed. In order to carry out the process, the print is first bleached in a solution of ferricyanide and potassium bromide of the following strength:—

Potassium ferricyanide	90 grains
Potassium bromide	30 ,,
Water	10 ounces

The bleaching is then followed by a short washing in running water, after which the print is immersed in the following solution:—

Schlippes salt	½ ounce
Water	10 ounces

In this solution the colour assumed by the print is a yellowish red; it is then placed to soak for a few minutes in a five-per-cent. solution of ammonia, after which it is again washed in running water and finally toned in the following solution:—

Copper chloride (ten-per-cent. solution)	½ ounce
Water	10 ounces
Hydrochloric acid (ten-per-cent. solution)	½ ounce

About thirty minutes' immersion is generally necessary in order to obtain the desired tone, after which the print is washed in running water and then dried.

PHYSICS.

By J. H. VINCENT, M.A., D.Sc., A.R.C.S.

LIQUID COMPASS.—The war has given a great impetus to the manufacture of liquid compasses, because they are more nearly dead-beat than the compass in which the card is carried solely on a pivot. In the liquid compass the weight of the card and of the magnet is very largely borne by the liquid, so that the friction on the pivot is reduced to a very small amount, the pivot being solely for the purpose of guiding the card. The liquid is a mixture of spirit and glycerine of such proportions that its viscosity allows the card to rotate fairly easily, but at the same time damps out its motion in a very short time. Liquid compasses are by no means a novelty, although hitherto they have not been very largely used as pocket instruments. Indeed, one of the earliest compasses—that of Petrius Peregrinus, described by him in 1269—was provided with a liquid upon which the card floated; and the method is often used in experimental work and in marine compasses. (*Engineering*, September 29th, 1916.)

REFRACTOMETERS.—A rapid method of determining refractive indices became possible by the application of the principle of total reflection, so that refractometers are instruments for measuring the critical angle. In Pulfrich's refractometer a right-angled glass prism is supported with one of the faces containing the right angle horizontal and the other vertical. On to the horizontal face a glass cell is cemented to hold the liquid under investigation. The refractive index of this liquid must be less than that of the glass prism. The horizontal plane of the prism is illuminated by mono-chromatic light entering the glass cell on the side away from the right angle. A ray entering the prism at grazing incidence will emerge from the vertical face of the glass prism, and is viewed through an observing telescope mounted on a graduated circle. This emerging

XUM

ray is a limiting one dividing the field into a dark and light portion, so that all the observer has to do is to fix the cross wires of the telescope on this division. The consequent reading gives by means of tables or calculation the refractive index of the liquid. If a solid body is to be studied, it is cut in the form of a right-angled prism and temporarily optically cemented to the top face of the glass prism by a suitable transparent liquid.

A CRITICAL TEST OF THE CRYSTALLOGRAPHIC LAW OF VALENCY VOLUMES.—In a paper in *The Philosophical Magazine* for November, 1916, Ogg and Hopwood show that the law of valency volumes of Pope and Barlow is notably departed from in the case of alkali sulphates. According to Pope and Barlow, the entire space occupied by a crystal can be regarded as a close-packed assemblage of approximately spherical cells of various sizes, representing by their relative volumes the spheres of influence of the component atoms of any particular crystalline structure. The volumes of the cellular domains thus allotted are supposed to be approximately in the ratio of the integers expressing the fundamental chemical valencies of their contained atoms. Using the methods and apparatus of Bragg, the authors have investigated the structure of the crystals of the alkali sulphates by means of x rays, and find that the unit rhombs of rubidium sulphate crystals are of almost exactly the same size as those of crystals of ammonium sulphate, or that eight atoms of an alkaline metal may be crystallographically exchanged for the forty atoms of the eight ammonium groups. The sum of the fundamental valencies of ammonium sulphate is twice that of the sum for an alkali metal sulphate, so that, according to Pope and Barlow, the volumes occupied by the elementary cell of the ammonium salt should be twice that occupied by the alkali metal sulphate.

RADIO-ACTIVITY.

By ALEXANDER FLECK, D.Sc.

THORIUM AND IONIUM.—Three papers on the interrelation between these two elements fall to be recorded. Two of them are contributed to a recent number of the *Monatshefte* by Hönigschmid and Horovitz, in which they describe their determination of the atomic weight of ordinary thorium, and then the value obtained by the same methods for the "thorium" separated by Auer von Welsbach from Joachimsthal pitchblende, which should be composed to a great extent of ionium, derived by disintegration from the uranium. The value which they obtained for ordinary thorium was 232·12, which is not materially different from the previously accepted value of 232·4. The "thorium" from pitchblende had been carefully purified, and its spectrum obtained, by Exner and Haschek. This showed no trace of any variation from the spectrum of ordinary thorium, but Hönigschmid and Horovitz's determination of the atomic weight of this material gave the value of 231·51 =0·014, which is materially lower—much beyond the limits of experimental error—than the value quoted above. This is, once more, confirmatory evidence of the truth of the isotopic theory. The true atomic weight of ionium, calculated from the experimentally derived values for uranium and thorium, must lie between 230·0 and 230·18, and, assuming the former value to be correct, it follows that there is thirty per cent. of ionium in Welsbach's material. The third paper by Stefan Meyer deals with the calculation of the period of average life of ionium from the data furnished by the above experiments. It is shown that that constant is $1{\cdot}45 \times 10^5$ years, which agrees well with previous values. This means that for every gramme of radium in existence there are fifty-eight grammes of ionium.

ZOÖLOGY.

By PROFESSOR J. ARTHUR THOMSON, M.A., LL.D.

BREASTBONE OF A GIANT BIRD.—In beds, probably of Eocene age, in Southern Nigeria, Mr. Eaglesome discovered part of the breastbone of a giant bird. The part was about five and a half inches long, and Dr. C. W. Andrews, who describes it, calculates that the whole was perhaps twice as large as that of a large wandering albatross (with a ten-foot-eight-inch spread of wings). The characters of the bone indicate that the bird, named by Dr. Andrews *Gigantornis eaglesomei*, was a powerful flier, and perhaps also a good swimmer and diver. Its probable affinities are with petrels and albatross.

POISON OF THE STING-RAY.—From the time of Aristotle down to the end of the nineteenth century the poison-organ of the spine of the sting-ray (*Trygon pastinacea*) remained unknown. Many thought that the troublesomeness of the wound was due to mucus getting in when the laceration was made by the serrated tail-spine. The instrument, it may be noticed, is renewed every year, though sometimes a new one sprouts before the old one has been shed. In 1905 Dr. Antonio Porta found the poison-organ in a paired groove on each side of the ventral surface of the spine, and Major H. Muir Evans has recently described its minute structure, and how the poisonous secretion is discharged. He notes that the staining reactions of the secretion are the same as those in the poison of the weever. The late Dr. Lo Bianco, of the Naples Zoölogical Station, reported that he saw a young man become extremely pale, and fall down almost senseless for a few minutes, from having received only a very small puncture when he was handling a sting-ray. A turtle in the great tank of the Aquarium was wounded under the flipper by a sting-ray, the spine breaking off. The reptile went off its food, and died in five days, the wound becoming very putrid.

THE HOME OF GUINEA-PIGS.—The probable ancestor of the domesticated guinea-pigs is *Cavia cutleri*, which is wild in Peru. Professor Castle has recently visited the headquarters of the stock, and finds that all, or almost all, the coat varieties of guinea-pig are known to the Peruvians, though they now pay most attention to size. Nine independent Mendelising unit-character variations are known to affect the coat of guinea-pigs. It may be said, with probable correctness, that "the guinea-pig has undergone in domestication more extensive variation in colour and coat characters than any other mammal, and that this variation has occurred almost, if not quite exclusively under the tutelage of the natives of Peru. This conclusion points either to a great antiquity of the guinea-pig as a domesticated animal, or to more rapid evolution by unit-character variation than by other natural processes." Professor Castle calls attention to the care that the natives give to breeding guinea-pigs. He desired to purchase a very large individual, but it could not be had, as it was the "padre" (sire) of the entire family. Size is of particular importance, because the animals form the meat supply of the native poor of Peru, and doubtless have done so since ancient times.

USES OF ODORIFEROUS GLANDS IN MONGOOSES.—Mr. R. I. Pocock, Curator of Mammals at the "Zoo," notes that one of the uses of the secretion of the highly developed anal glands of the mongoose is to make the animal's surroundings smell of itself. This serves the purpose of familiarising the creature with every square yard of its environment. Mr. Pocock refers to the use of tracks by many mammals. Rats escape from dogs by knowing exactly the position of a pipe or of a hole in a wire-net fence. "They make a beeline for the spot at full speed, and, apparently without ever seeing the hole, go straight through it, knowing the precise direction to take by complete familiarity with the track, owing, I believe, to the scent it holds." The secretion may also help individuals to keep together: one of the larger Indian species of mongoose (*Mungos vitticollis*) has been seen hunting in pairs. Finally, Hodgson has recorded that the secretion of the anal glands of *Mungos urva* is "aqueous, horribly foetid, and projectile to a great distance by the living animal." So that it may have an offensive function, as in skunks.

THE FACE OF THE SKY FOR JANUARY.

By A. C. D. CROMMELIN, B.A., D.Sc., F.R.A.S.

TABLE 60.

Date.	Sun. R.A.	Sun. Dec.	Moon. R.A.	Moon. Dec.	Mercury. R.A.	Mercury. Dec.	Venus. R.A.	Venus. Dec.	Jupiter. R.A.	Jupiter. Dec.	Saturn. R.A.	Saturn. Dec.	Neptune. R.A.	Neptune. Dec.
Greenwich Noon.	h. m.	°	h. m.	°	h. m.	°	h. m.	°	h. m.	°	h. m.	°	h. m.	°
Jan. 1	18 45·8	S. 23·0	1 16·5	N. 13·8	20 8·9	S. 21·5	16 45·3	S. 21·2	1 37·0	N. 8·8	8 2·4	N. 20·6	8 25·5	N. 19·0
„ 6	19 7·8	22·5	5 40·9	N. 25·6	20 27·3	19·5	17 11·9	22·0	1 37·8	8·9	8 0·8	20·7	8 25·0	19·0
„ 11	19 29·6	21·9	9 45·2	N. 10·3	20 30·4	17·8	17 38·7	22·6	1 39·0	9·0	7 59·1	20·8	8 24·5	19·1
„ 16	19 51·2	21·0	13 28·4	S. 14·9	20 14·6	17·2	18 5·7	22·9	1 40·5	9·2	7 57·4	20·9	8 23·9	19·1
„ 21	20 12·5	20·0	18 23·2	S. 24·7	19 48·3	17·6	18 32·8	22·9	1 42·3	9·4	7 55·7	21·0	8 23·3	19·1
„ 26	20 33·5	18·8	23 18·3	N. 0·5	19 28·5	18·5	18 59·9	22·7	1 44·3	9·6	7 54·0	21·1	8 22·7	19·2
„ 31	20 54·1	S. 17·5	3 39·8	N. 23·8	19 23·5	S. 19·4	19 26·8	S. 22·1	1 46·6	N. 9·8	7 52·3	N. 21·2	8 22·2	N. 19·2

TABLE 61.

Date.	Greenwich Noon. Sun. P	Sun. B	Sun. L	Jupiter. P	Jupiter. B	Jupiter. L_1	Jupiter. L_2	Jupiter. T_1	Jupiter. T_2	Midnight. Moon. P
	°	°	°	°	°	°	°	h. m.	h. m.	
Jan. 1 ...	+ 2·0	−3·2	162·8	−22·7	+2·9	16·6	176·5	9 24 *e*	5 4 *e*	Jan. 1 −21·4
„ 6 ...	− 0·4	3·7	96·9	22·6	2·9	41·0	147·5	8 44 *e*	5 53 *e*	„ 6 − 0·7
„ 11 ...	2·9	4·3	31·1	22·5	2·8	65·2	118·3	8 5 *e*	6 40 *e*	„ 11 +19·4
„ 16 ...	5·2	4·8	325·2	22·4	2·8	89·3	89·0	7 25 *e*	7 29 *e*	„ 16 +20·9
„ 21 ...	7·5	5·2	259·4							„ 21 − 4·0
„ 26 ...	9·8	5·7	193·6							„ 26 −23·0
„ 31 ...	−11·9	−6·0	127·7	−22·2	+2·8	113·2	59·5	6 46 *e*	8 18 *e*	„ 31 −12·0

P is the position angle of the North end of the body's axis measured eastward from the North point of the disc. B, L are the helio-(planeto-) graphical latitude and longitude of the centre of the disc. T is the time of transit of the zero meridian across the centre of the disc. In the case of Jupiter, System I refers to the rapidly rotating equatorial zone; System II to the temperate zones which rotate more slowly. To find intermediate passages of the zero meridian of either system across the centre of the disc, apply to T_1 T_2 multiples of $9^h\ 50^m{\cdot}6$, $9^h\ 55^m{\cdot}8$ respectively.

The letters *m*, *e* stand for morning, evening. The day is taken as beginning at midnight.

THE SUN is moving Northward with increasing speed. Nearest Earth at Noon on 3rd. Its semi-diameter diminishes from 16′ 18″ to 16′ 15″. Sunrise changes from $8^h\ 8^m$ to $7^h\ 43^m$; sunset from $3^h\ 58^m$ to $4^h\ 45^m$. There is now considerable solar activity, and a constant watch should be kept on the disc.

MERCURY is an evening star till the 19th, when it passes Inferior Conjunction and becomes a morning star. It is at East Elongation, 19° from Sun, on 3rd. Semi-diameter increases from 3″ to 5″, and then diminishes to 4″. Illumination $\frac{3}{8}$ at beginning of month, zero on 16th, $\frac{1}{3}$ at end of month.

VENUS is a morning star. The semi-diameter diminishes from 6″ to $5\frac{1}{2}$″. Illumination of disc increases from $\frac{7}{8}$ to $\frac{6}{7}$.

THE MOON.—Full $8^d\ 7^h\ 42^m$ *m*. Last quarter $16^d\ 11^h\ 42^m$ *m*. New $23^d\ 7^h\ 40^m$ *m*. First Quarter $30^d\ 1^h\ 1^m$ *m*. Apogee $10^d\ 8^h$ *m*. Perigee $23^d\ 1^h$ *e*. Semi-diameter 14′ 44″, 16′ 46″ respectively. Maximum librations 1^d 7° S., 1^d 7° W, 15^d 7° N., 17^d 8° E., 28^d 7° S., 29 8° W. The letters indicate the region of the Moon's limb brought into view by libration. E., W. are with reference to our sky, not as they would appear to an observer on the Moon. (See Table 62.) Attention is called to the fact that the maximum librations in longitude and latitude now occur nearly simultaneously.

ECLIPSES.—There will be a total eclipse of the Moon on the morning of January 8th. Moon enters Penumbra $4^h\ 36^m$, enters Umbra $5^h\ 50^m$, total eclipse from $7^h\ 0^m$ to $8^h\ 29^m$, leaves Umbra $9^h\ 39^m$, leaves Penumbra $10^h\ 53^m$. The first contact with Umbra occurs at 117° from N.Pt. to E., the last contact at 269° from N. to E.

The Moon sets in London at $8^h\ 10^m$, but considerably later in the West of England and in Ireland and Scotland. The eclipse will be seen in America under favourable conditions.

There will be a partial eclipse of the Sun on the morning of January 23rd. Invisible in British Isles, except for a possible glimpse at sunrise in East Kent and about Lowestoft. Partial eclipse visible over most of France, part of Scandinavia, the whole of Central and Eastern Europe, Northern Africa, including Egypt, Arabia, Persia, Afghanistan, N.W. corner of India, Western Siberia. The greatest eclipse, about $\frac{2}{3}$ of the Sun's disc, will be in Finland.

There will be seven eclipses (the maximum number possible) in 1917. This has not occurred since 1805 (I quote from Rev. S. J. Johnson, "Eclipses and Transits in Future Years"). It will happen again, after one Saros, in 1935.

MARS is low in the West and practically invisible.

JUPITER is in Aries. Has begun to advance. In quadrature with Sun on 17th. Near Moon on 1st. Equatorial diameter 41″, Polar 39″. Defect of illumination $\frac{2}{5}$″.

Configuration of satellites at $8^h\ 30^m$ *e* for an inverting telescope.

JUPITER'S SATELLITES.

Day.	West.	East.	Day.	West.	East.
Jan. 1	41 ○	3 2●	Jan. 17	431 ⊙	
,, 2	43 ○	12	,, 18	432 ○	1
,, 3	4312 ○		,, 19	431 ○	2
,, 4	432 ○	1	,, 20	4 ○	132
,, 5	431 ○	2	,, 21	42 ○	3 1●
,, 6	⊙	23	,, 22	421 ○	3
,, 7	2 ○	143	,, 23	○	3412
,, 8	1 ○	34 2●	,, 24	31 ○	24
,, 9	3 ○	124	,, 25	32 ○	14
,, 10	312 ○	4	,, 26	31 ○	24
,, 11	32 ○	14	,, 27	○	1324
,, 12	31 ○	24	,, 28	21 ○	34
,, 13	⊙	234	,, 29	2 ⊙	34
,, 14	2 ○	143	,, 30	○	324
,, 15	412 ○	3	,, 31	31 ○	42
,, 16	43 ○	12			

IV is due North of the disc on the 6th.

The following satellite phenomena are visible at Greenwich:—$1^d\ 5^h\ 57^m\ e$ II. Oc. D., $8^h\ 33^m\ e$ II. Oc. R., $8^h\ 33^m\ 57^s\ e$ II. Ec. D., $11^h\ 6^m\ 46^s\ e$ II. Ec. R.; $3^d\ 6^h\ 14^m\ e$ II. Sh. E.; $5^d\ 0^h\ 2^m\ m$ I. Tr. I., $9^h\ 21^m\ e$ I. Oc. D., $11^h\ 4^m\ e$ III. Oc. D.; $6^d\ 6^h\ 31^m\ e$ I. Tr. I., $7^h\ 49^m\ e$ I. Sh. I., $8^h\ 40^m\ e$ I. Tr. E., $9^h\ 58^m\ e$ I. Sh. E.; $7^d\ 7^h\ 20^m\ 18^s\ e$ I. Ec. R.; $8^d\ 4^h\ 27^m\ e$ I. Sh. E., $8^h\ 30^m\ e$ II. Oc. D., $11^h\ 6^m\ e$ II. Oc. R., $11^h\ 11^m\ 9^s\ e$ II. Ec. D.; $9^d\ 6^h\ 39^m\ e$ III. Sh. I., $8^h\ 8^m\ e$ III. Sh. E.; $10^d\ 6^h\ 13^m\ e$ II. Tr. E., $6^h\ 20^m\ e$ II. Sh. I., $8^h\ 52^m\ e$ II. Sh. E.; $12^d\ 11^h\ 16^m\ e$ I. Oc. D.; $13^d\ 8^h\ 25^m\ e$ I. Tr. I., $9^h\ 45^m\ e$ I. Sh. I., $10^h\ 35^m\ e$ I. Tr. E., $11^h\ 54^m\ e$ I. Sh. E.; $14^d\ 5^h\ 44^m\ e$ I. Oc. D., $9^h\ 16^m\ 3^s\ e$ I. Ec. R.; $15^d\ 5^h\ 4^m\ e$ I. Tr. E., $6^h\ 22^m\ e$ I. Sh. E., $11^h\ 5^m\ e$ II. Oc. D.; $16^d\ 5^h\ 3^m\ e$ III. Tr. I., $7^h\ 4^m\ e$ III. Tr. E., $10^h\ 41^m\ e$ III. Sh. I.; $17^d\ 6^h\ 15^m\ e$ II. Tr. I., $8^h\ 50^m\ e$ II. Tr. E., $8^h\ 58^m\ e$ II. Sh. I., $11^h\ 29^m\ e$ II. Sh. E.; $19^d\ 5^h\ 40^m\ 3^s\ e$ II. Ec. R.; $20^d\ 10^h\ 21^m\ e$ I. Tr. I.; $21^d\ 7^h\ 40^m\ e$ I. Oc. D., $11^h\ 11^m\ 46^s\ e$ I. Ec. R.; $22^d\ 4^h\ 50^m\ e$ I. Tr. I., $6^h\ 10^m\ e$ I. Sh. I., $7^h\ 0^m\ e$ I. Tr. E., $8^h\ 18^m\ e$ I. Sh. E.; $23^d\ 5^h\ 40^m\ 39^s\ e$ I. Ec. R., $9^h\ 6^m\ e$ III. Tr. I., $11^h\ 8^m\ e$ III. Tr. E.; $24^d\ 8^h\ 54^m\ e$ II. Tr. I.; $26^d\ 5^h\ 39^m\ e$ II. Oc. R., $5^h\ 45^m\ e$ II. Ec. D., $8^h\ 17^m\ 37^s\ e$ II. Ec. R.; $27^d\ 6^h\ 22^m\ 12^s\ e$ III. Ec. R.; $28^d\ 9^h\ 37^m\ e$ I. Oc. D.; $29^d\ 6^h\ 47^m\ e$ I. Tr. I., $8^h\ 5^m\ e$ I. Sh. I., $8^h\ 56^m\ e$ I. Tr. E., $10^h\ 14^m\ e$ I. Sh. E.; $30^d\ 7^h\ 36^m\ 19^s\ e$ I. Ec. R. Eclipses of the satellites take place low right of the disc, taking the direction of the belts as horizontal. Attention is called to the rather rare phenomenon that occurs on the 1st, 8th, and 26th, when satellite II can be seen to reäppear from Occultation just before it disappears in eclipse.

SATURN is in Cancer, in opposition on 17th; near Moon on morning of 9th. Polar semi-diameter 9½″. Major axis of ring 46½″, Minor 17″. Angle P −7°·3.

East Elongations of Tethys (every fourth given) $1^d\ 4^h\cdot2\ e$, $9^d\ 5^h\cdot4\ m$, $16^d\ 6^h\cdot5\ e$, $24^d\ 7^h\cdot7\ m$, $31^d\ 8^h\cdot8\ e$; of Dione (every third given) 4^d noon, $12^d\ 4^h\cdot9\ e$, $20^d\ 9^h\cdot8\ e$, $29^d\ 2^h\cdot7\ m$.; of Rhea (every second given) $4^d\ 11^h\cdot9\ m$, $13^d\ 0^h\cdot5\ e$, $22^d\ 1^h\cdot1\ e$, $31^d\ 1^h\cdot7\ e$. For Titan and Japetus E., W. denote East and West Elongations; S., I. Superior and Inferior Conjunctions. Titan $3^d\ 3^h\cdot7\ e$ S., $7^d\ 5^h\cdot7\ e$ E., $11^d\ 1^h\cdot1\ e$ I., $15^d\ 9^h\cdot6\ m$ W., $19^d\ 0^h\cdot9\ e$ S., $23^d\ 3^h\cdot0\ e$ E., $27^d\ 10^h\cdot4\ m$ I., $31^d\ 6^h\cdot9\ m$ W. Japetus $10^d\ 8^h\cdot5\ e$ E., $30^d\ 2^h\cdot6\ e$ I.

URANUS is too near the Sun for convenient observation.

NEPTUNE is in Cancer: in opposition on 24th. Near Moon on evening of 9th.

COMETS.—Wolf's Comet (b 1916) may be seen as a morning star in January. It will probably be of the tenth magnitude, or thereabouts, and should be looked for in the east, just before the dawn. The following ephemeris, for $4^h\ m$, is by Mr. R. T. Crawford:—

Day.	R.A.	S. Decl.	Day.	R.A.	S. Decl.
	h. m. s.	° ′		h. m. s.	° ′
Jan. 1	16 3 3	6 5	Jan. 17	16 33 52	5 52
,, 3	16 6 48	6 5	,, 19	16 37 51	5 48
,, 5	16 10 35	6 5	,, 21	16 41 52	5 43
,, 7	16 14 23	6 4	,, 23	16 45 55	5 38
,, 9	18 18 13	6 3	,, 25	16 49 59	5 32
,, 11	16 22 5	6 1	,, 27	16 54 5	5 26
,, 13	16 26 0	5 58	,, 29	16 58 12	5 19
,, 15	16 29 55	5 56	,, 31	17 2 21	5 11

The Comet will steadily get brighter up till June next, when it will probably be visible to the naked eye.

EROS.—An ephemeris of this small planet was given last month.

GREENWICH TIMES OF MERIDIAN TRANSIT OF CERTAIN BRIGHT STARS.—These are given to facilitate the determination of time by observations with small transit instruments. The times for intermediate days may be obtained by simple interpolation. The Greenwich time of the stars crossing the meridians of other places may be obtained by expressing the longitude of these places in time, diminishing them by $9^s\cdot83$ per hour, and proportionately for fractions of an hour, then

TABLE 62. Occultations of Stars by the Moon, visible at Greenwich.

Date.	Star's Name.	Magnitude.	Disappearance.		Reäppearance.	
			Time.	Angle from N. to E.	Time.	Angle from N. to E.
1917.			h. m.	°	h. m.	°
Jan. 2 ...	26 Arietis	6·2	9 1 *e*	10	9 40 *e*	310
,, 3 ...	μ Arietis	5·7	2 57 *m*	153	3 13 *m*	187
,, 3 ...	66 Arietis	6·1	11 17 *e*	120	0 13 *m**	222
,, 6 ...	118 Tauri	5·4	5 12 *m*	66	5 57 *m*	308
,, 6 ...	5 Geminorum	5·9	11 52 *e*	192	—	—
,, 7 ...	44 Geminorum	5·9	11 56 *e*	121	1 15 *m**	273
,, 8 ...	79 Geminorum	6·3	5 51 *e*	120	6 47 *e*	258
,, 8 ...	85 Geminorum	5·2	11 52 *e*	84	1 4 *m**	322
,, 9 ...	10 H Cancri	6·1	5 45 *m*	98	6 42 *m*	233
,, 11 ...	ξ Leonis	5·1	1 47 *m*	99	3 2 *m*	325
,, 14 ...	13 B Virginis	5·9	7 42 *m*	108	—	—
,, 26 ...	16 Piscium	5·7	6 50 *e*	68	7 51 *e*	235
,, 27 ...	WZC 20	7·2	5 0 *e*	86	—	—
,, 31 ...	36 Tauri	5·6	8 51 *e*	138	9 38 *e*	211

The asterisk indicates the day following that given in the date column.
From New to Full, Disappearances occur at the Dark Limb; from Full to New, Reäppearances.

TABLE 63.

Day.	α Arietis.	Aldebaran.	Castor (mean of Stars).
	N. Dec. 23° 4′.	N. Dec. 16° 21′.	N. Dec. 32° 4′.
	h. m. s.	h. m. s.	h. m. s.
Dec. 31	7 22 59·13 *e*	9 51 15·46 *e*	0 48 55·74 *m**
Jan. 10	6 43 39·91 *e*	9 11 56·33 *e*	0 9 36·80 *m**
,, 20	6 4 20·66 *e*	8 32 37·15 *e*	11 30 17·79 *e*
,, 30	5 25 1·42 *e*	7 53 17·95 *e*	10 50 58·74 *e*

* Morning of January 1, 11 respectively.

applying the result to the tabular time—positively for West longitudes, negatively for East ones. (See Table 63.)

Observers who know Greenwich Time can use the Table to obtain their South Point.

SUN after clock January 1, $214^{s}\cdot54$; January 6, $351^{s}\cdot93$; January 11, $477^{s}\cdot66$; January 16, $588^{s}\cdot98$; January 21, $683^{s}\cdot59$; January 26, $759^{s}\cdot41$; January 31, $814^{s}\cdot82$. These are the equations of time for the moment of solar transit at Greenwich.

VARIABLE STARS.—Stars reaching their maxima in or near January, 1917, are included. The lists in recent months may also be consulted. (See Table 64.)

METEOR SHOWERS (from Mr. Denning's List):—

Date.	Radiant. R.A.	Radiant. Dec.	Remarks.
Jan. 2–3 ...	230°	+ 53°	Swift, long paths.
,, 3 ...	156	+ 41	Swift.
,, 11 ...	220	+ 13	Swift, streaks.
,, 17 ...	295	+ 53	Slow, bright.
,, 17–23 ...	159	+ 27	Swift.
,, 25 ...	131	+ 32	Swift.
,, 29 ...	213	+ 52	Very swift.

TABLE 64. LONG-PERIOD VARIABLE STARS.

Star.	Right Ascension.	Declination.	Magnitudes.	Period.	Date of Maximum.
	h. m. s.	° ′		d.	
T Ceti	0 17 28	−20 32	5·4 to 6·9	162	1917—Feb. 2
V Cancri	8 16 53	+17 34	7·1 to 12·8	272	,, Jan. 30
R Leon. Min.	9 40 29	+34 54	7·1 to 12·9	371	,, Jan. 25
S Virginis	13 28 34	− 6 45	6·2 to 12·5	377	,, Jan. 23
S Coronae Bor.	15 17 55	+31 40	6·1 to 13·4	362	,, Feb. 4
RS Herculis	17 18 9	+23 0	7·5 to 12·8	220	,, Jan. 20
T Draconis	17 55 6	+58 13	7·5 to 12·0	426	,, Feb. 7
R Vulpeculae	21 0 36	+23 29	7·1 to 13·6	137	,, Jan. 13

Minima of Algol $3^{d}\ 2^{h}\cdot8\ e$, $9^{d}\ 8^{h}\cdot4\ m$, $12^{d}\ 5^{h}\cdot2\ m$, $15^{d}\ 2^{h}\cdot0\ m$, $17^{d}\ 10^{h}\cdot8\ e$, $20^{d}\ 7^{h}\cdot6\ e$, $23^{d}\ 4^{h}\cdot4\ e$.
Period $2^{d}\ 20^{h}\ 48^{m}\cdot9$.

Principal Minima of β Lyrae $1^{d}\ 10^{h}\cdot6\ e$, $14^{d}\ 8^{h}\cdot7\ e$, $27^{d}\ 6^{h}\cdot8\ e$. Period $12^{d}\ 22^{h}\cdot1$.

REVIEWS.

GEOLOGY.

Agricultural Geology.—By R. H. RASTALL. 328 pages. 5 illustrations. 5-in. × 8-in.

(Cambridge University Press. Price 10/6.)

In this, the most important recent book on the subject, Mr. Rastall has brought together an account of the phenomena shown in the formation of soils from rock, and in such related actions as determine the lie of the land and the configuration of the country generally. It is called "Agricultural Geology" because it is specially written for the agriculturist who realises the necessity for a working knowledge of geology, but has not the time, even if he had the taste, to approach the subject from the stratigraphical point of view adopted by many of the modern geologists.

Thus it happens that nearly two-thirds of the book is devoted to the consideration of weathering, transport, drifts, the geology of water supply and drainage, and only about one-third to the more usual stratigraphical geology. In the main, the book deals with British conditions, but the author has cast his net very wide, and gives a useful account of the soils of other countries. A valuable feature of the

book is the number of references given. Mr. Rastall has made good use of his collection of papers and reports, and has industriously put them together with great advantage to the student.

The geologist is naturally at his best in the ordinary straightforward case where the soil is derived from the rock, and can therefore only be fully understood when the geological phenomena are worked out. Over a good deal of our country this is the case: the solid rock and the soil are related so closely that the man who knows his way about can tell from the look of the rock just what the soil is likely to be, and what will be the chief vegetation characteristics; and, conversely, he can point out and explain the correlation between rocks, soils, scenery, and vegetation. Over much of the country, however, this does not hold: the soil has been brought from a distance during the Ice age and deposited on the top of rocks with which it has nothing in common, so that no knowledge of the rock, however intimate, helps in understanding the soil. Thus the agriculturist is concerned chiefly with the so-called "Drift Maps" on which these superficial or drift deposits are marked, and he is interested only in the "Solid Geology" map, which shows the underlying rocks when these have actually given rise to the soil.

Returning to the ordinary case of soil formation from underlying rock, an interesting relationship has been brought out by the Russian investigators. The decompositions involved in the weathering processes have been much studied, and it is found that they depend a good deal on climate. One and the same rock may give rise to wholly different soils under different climatic conditions; thus we get soils rich in silica in one climate, but under subtropical conditions soils arise which are very rich in iron or in alumina. In any large Continental area, like Russia, the soils can be grouped according to climatic zones, the effect of climate overriding that of original rock. Within these zones, however, the rock plays the determining part.

Another great relationship was brought out by the Dutch chemist, Van Bemellen. The British chemist, Graham, set up the distinction between colloids and crystalloids, the former being jelly or glue-like substances, the latter being such crystalline substances as sugar, salt, and so on. Most chemists have confined themselves to crystalloids, because they are the nicest and cleanest to work with, and practically all school and college chemistry deals exclusively with them. Colloids have wholly different properties, including a great capacity for sticking to other substances and considerable difficulty of characterisation, which sufficiently explains why they have been less popular than the crystalloids. But, as Van Bemellen has shown, soil is mainly colloidal in its behaviour, and so it happens that most of the textbook chemistry is inapplicable to the soil, and is likely to remain so until more attention is given to colloids.

There is great scope for the further study of the soil, both in the laboratory and in the field. Probably nothing is more urgently needed in the reconstruction work that lies ahead when war is over than a systematic stocktaking of the agricultural position, and an integral part of this will be a soil survey. Here the local scientific societies can render important help, for they can collect and record information that will prove of great value when the survey comes to be made.

E. J. RUSSELL.

PHYSICS.

The Physical Properties of Colloidal Solutions.—By E. F. BURTON. 220 pages. 18 illustrations. 9-in. × 6-in.

(Longmans, Green & Co. Price 6/- net.)

This book forms one of the series of monographs on physics, edited by Sir J. Thomson and Dr. F. Horton, the object of which is to incorporate in a convenient form researches on a particular branch of the science which are scattered in various journals and books. The subject of colloids is one which concerns both physics and chemistry, and many of the recent advances of the latter science have been based on the investigations of colloidal phenomena In the present monograph, however, the physical aspect is mainly considered, and it is only in the last chapter that the author discusses some of the practical applications of the study of colloidal solutions, such as in the purification of water, in agriculture, and in dyeing. The other chapters include the preparation and classification of colloids, the Brownian movement, optical and electrical phenomena, and the coagulation of colloids. A particularly interesting and valuable section deals with the invention of the ultramicroscope and describes the various forms of the instrument and its uses. Full references are given on each page, and there is an excellent classified bibliography after each chapter. As a practical handbook for the laboratory the book should find a welcome in many directions.

C. A. M.

NOTICES.

MR. PONTING'S LECTURES.—We alluded last month to the Lectures on the Antarctic which Mr. Ponting is giving in the Philharmonic Hall, London, and it is of interest to point out that the portrait of Captain Scott, which we were able to give in Figure 193, was the last taken of him, and had not been previously published.

THE TEACHER'S POCKET DIARY. — We have received from Messrs. Charles Letts & Co. their useful pocket diary for teachers, which gives a large number of educational fixtures and much information of special value to teachers, in addition to what is usually contained in a modern diary.

BRITISH WOOD-LICE. — Dr. Walter E. Collinge announces the publication of a Monograph of the Terrestrial Isopoda of the British Isles, to be issued in twelve parts, comprising altogether three hundred pages, with thirty plates and numerous text figures. Parts I and II will be ready early in 1917, and the price of each part to subscribers will be five shillings and threepence post free. Dr. Collinge writes from the University, St. Andrews.

THE SCIENTIST'S REFERENCE BOOK AND DIARY.—"The Scientist's Diary" is printed by Messrs. Charles Letts & Co., and published by Messrs. James Woolley, Sons & Co., Ltd., of Manchester. On many previous occasions we have commended it to our readers, and on its nineteenth appearance we do so again. It contains many pages of general scientific interest which can conveniently be consulted.

FIELD GLASSES FOR THE FRONT.—Lady Roberts writes of the success of the late Lord Roberts's appeal for the loan of field glasses and telescopes (upwards of twenty-six thousand having been received) and asks for more. Lady Roberts's Field Glass Fund may be addressed c/o the National Service League, 72, Victoria Street, S.W. It has been entrusted by the Ministry of Munitions with the purchase of glasses from those who cannot afford to lend them.

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